CLAIMS

We claim:

1. An apparatus for the collection and focusing of gas-phase ions at or near atmospheric pressure for the introduction of said ions into an analytical apparatus, the apparatus comprising:
   a. a dispersive source of ions.
   b. a stratified body consisting of a plurality of elements, said elements comprise alternating layers of metal electrodes and insulating material, each said electrode having successively smaller apertures wherein said apertures form an ion-funnel having an entry at largest aperture of first metal electrode and an exit at smallest aperture of last metal electrode, said smallest aperture forming inlet aperture into said analytical apparatus;
   c. first means for maintaining a potential difference between said ion source and said metal electrode with largest aperture whereby electrostatic filed at said metal aperture with largest aperture which is equal to that required to pass substantially all said ions through said largest aperture into said ion funnel;
   d. second means for maintaining a potential difference along the axis of said ion funnel whereby electrostatic fields is equal to that required to pass substantially all said ions through said ion funnel, through said inlet aperture, and into said analytical apparatus.

2. Apparatus as in claim **1** wherein said analytical apparatus comprises a mass spectrometer or ion mobility spectrometer or combination thereof.

3. Apparatus as in claim **1** wherein said inlet aperture comprises a conductive end of a capillary tube, wherein said capillary tube is the atmospheric or near atmospheric pressure inlet to the vacuum chamber of a mass spectrometer.

4. Apparatus as in claim **1** wherein said gas-phase ions are formed by means of atmospheric or near atmospheric ionization, electrospray, atmospheric pressure chemical ionization, laser desorption, photoionization, or discharge ionization sources; or a combination thereof.

5. Apparatus in claim **1** further including a pure gas supplied in such a way between the said inlet aperture and upstream adjacent metal laminate, whereby substantially all said gas flows into and out through said ion funnel flowing counter to trajectories of said gas-phase ions.

6. An apparatus for the collection and focusing of gas-phase ions or charged particles at or near atmospheric pressure for the introduction of said ions into the vacuum system of a mass spectrometer, the apparatus comprising:

a. a dispersive source of ions.

b. a laminated high-transmission surface populated with a plurality of openings through which substantially all said ions pass unobstructed, said laminated high transmission surface having a insulating base and metal laminate on topside and underside of said insulating base;

c. a stratified body consisting of a plurality of elements, said elements comprise alternating layers of metal and insulating laminates, each said element having successively smaller apertures wherein said apertures form an ion-funnel having an entry at the largest aperture of first metal laminate and an exit at the smallest aperture of last metal electrode said smallest aperture forming inlet aperture into said vacuum system, whereby approximately all said ions from said ion source pass unobstructed into said vacuum system of said mass spectrometer;

d. first means for maintaining a potential between said ion source and said laminated high transmission surface which is equal to that required to cause substantially all said ions from said ion source to migrate towards said metal laminate on topside of said insulating base and pass through said openings in said laminated surface, whereby electrostatic fields at said metal laminate on said underside is greater than electrostatic field at said topside of said base;

e. second means for maintaining a potential difference between said metal laminate on underside of said insulating base and said stratified body, whereby substantially all ions from said high transmission surface pass into said entry of said stratified body;

f. third means for maintaining a potential difference along the axis of said ion funnel whereby electrostatic fields is equal to that required to pass substantially all said ions to pass through said ion funnel, through said inlet aperture, and into said vacuum system of said mass spectrometer.

7. Apparatus as in claim **6** wherein said mass spectrometer is configured with an ion mobility spectrometer, whereby ion analysis is performed in a tandem manner.

8. Apparatus as in claim **6** wherein said gas-phase ions are formed by means of atmospheric or near atmospheric ionization, electrospray, atmospheric pressure chemical ionization, laser desorption, photoionization, or discharge ionization sources; or a combination thereof.

9. Apparatus in claim **6** further including a pure gas supplied in such a way between the said inlet aperture and upstream adjacent metal laminate, whereby substantially all said gas flows into and out through said entry of said ion funnel flowing through said polarity of openings in said laminated high-transmission surface flowing counter to trajectories of said gas-phase ions.

10. Apparatus in claim **6** further including funnel-focusing and ring electrodes incorporated in said metal laminate on underside of said insulating base, said funnel-focusing and ring electrodes are supplied with fourth and fifth electrostatic potentials, said funnel-focusing electrode is on-axis with said inlet aperture while said ring electrode is axial symmetric with said focusing electrode, wherein said funnel-focusing and ring electrode shape the electrostatic field lines between said high transmission surface and said entry of said ion funnel, wherein substantially all said ions passing through said laminated surface are directed into said entry of said ion funnel and pass through said ion funnel into said vacuum system of a mass spectrometer.

11. Apparatus in claim **6** further including particle stop in said metal laminate on topside of said insulating base, said particle stop is an electrode that shapes the electrostatic field lines at the top surface of laminated high transmission surface between said high transmission surface, wherein substantially all said ions are diverted away from said particle stop and pass through said laminated surface and substantially all neutral particles from said ion source impact on said particle stop.

12. A Method for the collection and transfer of charged particles or ions from a highly dispersive area or source at or near atmospheric pressure and focusing approximately all said charged particles or ions into a mass spectrometer for gas-phase ion analysis, the method comprising:

a. providing a perforated laminated high-transmission surface populated with a plurality of holes made up of an insulating base and metal laminates contiguous with topside and underside of said base;

b. applying an electrostatic potential gradient across said laminated surface, such that electrostatic field lines between said ion source and said laminated

surface are concentrated into said holes wherein substantially all said ions in said ion source are directed through said holes into a focusing region downstream of said laminated high-transmission surface;

c. providing electrostatic attraction to said ions in said focusing region with an electrostatic field generated by a stratified body or ion funnel, said ion funnel made up of alternating electrodes and insulating bases, each said electrode and base having successively smaller apertures, having an entry at the largest aperture of first electrode and an exit or inlet aperture at the smallest aperture of last electrode, said electrostatic attraction maintained by a potential gradient across said electrodes wherein the electrostatic potential applied to each electrode is greater then said electrostatic potential applied to adjacent or upstream electrode, such that electrostatic field lines between said laminated surface and said ion funnel are concentrated into said entry as a reduced cross-sectional area;

d. directing substantially all said ions from said focusing region into said entry and out of said inlet aperture, thereby focusing said charged particles into said mass spectrometer.

13. The method of claim **12** further comprising the step of directing ions as they exit said inlet aperture by providing electrostatic or oscillatory potentials to lens or electrodes, or combination thereof, in said mass spectrometer.

14. The method of claim **12** further comprising the step of directing a flow of gas counter to the trajectories of said ions as they are directed through said ion funnel.

15. A Method for the collection and transfer of charged particles or ions from a highly dispersive area or source at or near atmospheric pressure and focusing

approximately all said charged particles or ions into a mass spectrometer for gas-phase ion analysis, the method comprising:

a. providing a stratified body or ion funnel made up of alternating electrodes and insulating bases, each said electrode and base having successively smaller apertures, having an entry at the largest apertures of first electrode and an exit or inlet aperture at the smallest aperture of last electrode;
b. applying an electrostatic potential gradient across said electrodes wherein the electrostatic potential applied to each electrode is greater then said electrostatic potential applied to adjacent or upstream electrode, such that electrostatic field lines between said source of gas-phase charged particles or ions and said ion funnel are concentrated into apertures of said ion funnel;
c. directing ions from said ion source into said largest aperture and out of the inlet aperture, thereby focusing the charged particles into said mass spectrometer.

16. The method of claim **15** wherein said ions are formed in a pulsed or static fashion, or a combination thereof.

17. The method of claim **15** wherein said method further includes the step of operating said ion source in an oscillatory fashion by providing oscillatory electrical potentials to said ion source.

18. The method of claim **15** wherein said method further includes the step of directing ions as they exit said inlet aperture by providing electrostatic and oscillatory potentials to lens or electrodes in said mass spectrometer.

19. The method of claim **15** wherein said method further includes the step of directing a flow of gas counter to the trajectories of said ions as they are directed through said ion funnel.